

I N T E R A G E N C Y P E R C H L O R A T E S T E E R I N G C O M M I T T E E

PERCHLORATE STAKEHOLDERS FORUM

Government & Organizational Acronyms

ADEQ - Arizona Department of Environmental Quality
ADHS - Arizona Department of Health Services
AFRL/HEST -Air Force Research Laboratory/Operational Toxicology Branch
AFRL/MD -Air Force Research Laboratory-Materials and Manufacturing Directorate
ATSDR -Agency for Toxic Substances and Disease Registry
AWWA -American Water Works Association
AWWARF -American Water Works Association Research Foundation
CA DHS -California Department of Health Services
CRIT -Colorado River Indian Tribes
DoD -Department of Defense
EPA - U.S. Environmental Protection Agency
IPSC -Interagency Perchlorate Steering Committee
NASA -National Aeronautics & Space Administration
NCEA -National Center for Environmental Assessment (part of EPA's ORD)
NERL -National Exposure Research Laboratory (part of EPA's ORD)
NDEP -Nevada Division of Environmental Protection
NHEERL -National Health and Environmental Effects Research Laboratory (part of EPA's ORD)
NIEHS -National Institute for Environmental Health Sciences
NRMRL -National Risk Management Research Laboratory (part of EPA's ORD)
OGWDW -Office of Ground Water and Drinking Water (part of EPA's OW)
ORD -Office of Research and Development (part of EPA)
OSWER -Office of Solid Waste and Emergency Response (part of EPA)
OW -Office of Water (part of EPA)
SRLB -Sanitation and Radiation Laboratory Branch (part of CA DHS)
TERA -Toxicology Excellence for Risk Assessment (a nonprofit association)
UDEQ -Utah Department of Environmental Quality
USAF -United States Air Force

Glossary of Terms

Absorption: Uptake of substances into or across tissues, e.g., the gastrointestinal tract, skin, or respiratory tract. See *ADME*.

Acute effect: An adverse (toxic) effect resulting from an acute exposure.

Acute exposure: One dose or multiple doses occurring within a short time (24 hours or less).

ADME study -Absorption, Distribution, Metabolism and Elimination: A study that characterizes the likely internal disposition of a chemical in an organism by defining these factors.

Adsorption: Adhesion of molecules of gas, liquid, or dissolved solids to a surface. Adsorption, in which activated carbon removes organic matter, is often used as a technique for treating water.

Aerobic: Describes processes which use oxygen or occur in its presence. Contrast with *anaerobic*.

Air stripping: A treatment system that removes volatile organic compounds from contaminated groundwater or surface water by forcing an airstream through the water and causing the compounds to evaporate.

Anaerobic: Describes processes which occur in the absence of oxygen. Obligately anaerobic processes cannot occur in the presence of oxygen. For example, bacteria which are obligate anaerobes malfunction or die in the presence of oxygen. Contrast with *aerobic*.

Aquifer: An underground formation, or group of formations, that can store and supply *groundwater* to wells and springs.

Benchmark value: A value used to make comparisons.

Benign: Not malignant; remaining localized.

Bias: Bias provides a measure of the systematic or determinate error of an analytical method. It is determined by analyzing one or more standard reference materials with known concentration. Any difference between the mean of the analysis and the known analyte concentration of the standard reference material can be attributed to bias. Bias is typically a result of one or a combination of three types of systematic error: instrumental errors, operator error, and method error.

Bioaccumulants: Substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted.

Bioassay: Study of living organisms to measure the effect of a substance, factor, or condition by comparing before-and-after exposure or other data.

Bioavailability: The extent to which living things can extract toxic chemicals from soil and other materials. Material that is not bioavailable is not available to cause toxic effects.

Bioremediation: The use of biological organisms (often bacteria, but sometime plants or others) to degrade a contaminant so that it reaches safe levels. This can refer to either the construction of special reactors or the introduction of certain species in an area to promote remediative activity.

Carcinogen: An agent capable of inducing a cancer response.

Carcinogenesis: The origin or production of cancer, very likely a series of steps. The carcinogenic event so modifies the genome and / or other molecular control mechanisms in the target cells that then can give rise to a population of altered cells that progress to neoplasia.

Catalyst: A substance that lowers the activation barrier (see *kinetics*) of a chemical reaction. Catalysts can be very simple or very complicated chemical species. Complex macromolecular catalysts manufactured by living organisms are called enzymes; most enzyme names end with the suffix “-ase.” Enzymes that catalyze chemical reductions are called reductases. Some bacteria possess reductases that let them use perchlorate for metabolism.

Chronic effect: An effect due to either accumulation of a chemical or to damage that is either repeated or not repaired occurs after an exposure. For example, skin cancer may be a chronic effect of sun-bathing, while sunburn is an acute effect.

Chronic exposure: Multiple exposures occurring over an extended period of time, typically a significant fraction of the animal or individual's lifetime.

Chronic study: A toxicity study designed to measure the (toxic) effects of chronic exposure to a chemical.

Clinical study: Pertaining to or founded on actual observations and treatment of patients.

Community involvement: Two-way communications with the public to foster understanding of EPA programs and actions and to increase citizen input into EPA decisions.

Complexation: The chemical process in which one chemical species reversibly bonds with another. For example, a substrate complexes with an enzyme, $E + S \rightleftharpoons E \cdot S$, or a cupric cation complexes with ammonia, $Cu^{2+} + 4 NH_3 \rightleftharpoons Cu(NH_3)_4^{2+}$.

Concentration: A term that describes the amount of one substance dissolved in a given amount of another substance.

Confounder: A condition or variable that may be a factor in changing the results of the agent under study. The effects of such factors must be discerned through careful experimental design and analysis.

Contaminant Candidate List (CCL): A list published by EPA of contaminants that are not currently subject to a *National Primary Drinking Water Regulation* and are known or anticipated to occur in public water systems.

Critical effect: The first adverse effect, or its known precursor, that occurs as the dose rate increases.

Development Toxicity Study: The study of adverse effects on the developing organism (including death, structural abnormality, altered growth or functional deficiency) resulting from exposure prior to conception (in either parent), during prenatal development, or postnatally up to the time of sexual maturation.

Dose-response assessment: The process of characterizing the relation between the dose of an agent administered or received and the incidence or magnitude of an adverse health effect in exposed populations and estimating the incidence or magnitude of the effect as a function of human exposure to the agent. It takes into account conditions of the dose administration or exposure (e.g., magnitude, frequency, duration, route) and other variables that may affect response (e.g., age, lifestyle, gender). A component of risk assessment.

Dose-response relationship: A relationship between the amount of an agent (either administered, absorbed, or believed to be effective) and changes in certain aspects of the biological system (usually toxic effects), apparently in response to that agent. For example, a small dose of carbon monoxide may cause drowsiness; a large dose can be fatal.

Electrochemistry: The branch of chemistry that deals with the study of oxidation-reduction reactions (see below) and their relationship with electric current. The term “electrochemical” is often used to describe chemical processes that are brought about using electric power.

Electrodialysis: A technique which separates ionic species in a liquid medium. The ions are caused to migrate by an electric field and they move through alternating chambers of semi-permeable membranes. This produces alternating regions of high concentration, the concentrate, and low concentration, the diluate.

Elimination (excretion): The act of expulsion or of extrusion, especially of expulsion from the body such as in the urine or feces. Toxicants are eliminated from the blood by biotransformation (metabolism), excretion, and accumulation at various storage sites. The relative importance of these processes depends on the physical and chemical properties of the toxicant.

Eluent: The mobile phase used in liquid chromatography, such as *ion chromatography* to carry the analytes through the stationary phase which separates them because they are attracted to the stationary phase.

Endpoints (or toxicological endpoints): A response measure in a toxicity study (*bioassay*). See also target tissue. Some toxic effects are reversible and others are irreversible. Reversibility may depend on the magnitude, timing or type of damage.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development and enforcement of environmental laws, regulations, and policies.

Enzyme: See *catalyst*.

Epidemiology study: A method of obtaining information on the toxicity of a suspect chemical in humans by comparing the health status of a group of people who have been exposed to the suspect chemical to that of a comparable non-exposed group (called "controls") or to population statistics from disease registries. The study attempts to identify any increase in disease in the exposed group that is due to exposure to the suspect chemical.

Exposure: Contact with a contaminant in the environment. Exposure may be oral (by mouth), dermal (through the skin), or by inhalation (breathing).

Exposure assessment: The process of measuring or estimating the intensity, frequency, and duration of human exposures to an agent currently present in the environment or of estimating hypothetical exposures that might arise from the release of a new chemical into the environment. A component of risk assessment.

Feedback system: A system in which the value of some output quantity is controlled by feeding back the value of the controlled quantity and using it to manipulate an input quantity so as to bring the value of the controlled quantity closer to a desired value. Also known as a closed-loop control system. An example is the regulation of thyroid hormone synthesis and secretion in the thyroid gland by feedback on the pituitary by the amount of circulating thyroid hormones.

Fulvic materials: Found in untreated waters, these are naturally occurring substances that (1) result from the decomposition of living things, (2) are resistant to further degradation in the environment, and (3) remain soluble regardless of *pH*.

Groundwater: The supply of fresh water found beneath the Earth's surface, usually in *aquifers*, which supply wells and springs. Because groundwater is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Hazard identification: The process of determining whether exposure to an agent can cause an increase in the incidence or magnitude of an adverse health effect. It involves characterizing the nature and strength of causation. A component of risk assessment.

Homeostasis: The attainment of a steady state, or complete balance, between the inputs and outputs of a system.

Human equivalent dose: The human dose of an agent that is believed to induce the same magnitude of adverse effect as that which the known animal dose has induced in a toxicity study.

Humic materials: Found in untreated waters, these are naturally occurring substances that (1) result from the decomposition of living things, (2) are resistant to further degradation in the environment, and (3) remain soluble only at high pH (basic conditions), precipitating (coming out of solution as a solid) at low pH (acidic conditions). Humic materials often serve as ion exchangers (see *ion exchange*) because of their many active sites.

Humus: A brown or black amorphous mass of decayed organic material found in soils. Humus is derived from natural biological and chemical decomposition of organic matter, such as leaf litter and dead plants.

Hydrated: Containing water or complexed (see *complexation*) with water molecules in well-defined ratios. The term “hydrous” describes substances that contain varying amounts of water.

Hyperthyroidism: A condition of excessive functional activity of the thyroid gland and excess secretion of thyroid hormones marked by goiter, rapid heart rate, palpitations, fatigability, nervousness and tremor, heat intolerance and excessive sweating, warm, smooth, moist skin, weight loss, muscular weakness, hyperdefecation, emotional lability, and eye changes.

Hypothyroidism: Deficiency of thyroid activity. In adults, it is most common in women and is characterized by decrease in basal metabolic rate, tiredness and lethargy, sensitivity to cold, and menstrual disturbances. In infants, severe hypothyroidism leads to cretinism. In juveniles, the manifestations are intermediate, with less severe mental and developmental retardation and only mild symptoms of the adult form. If the hypothyroidism is due to pituitary deficiency of TSH secretion, it is called secondary hypothyroidism.

Immunotoxicity study: An evaluation of the structure and function of the immune system, including humoral (antibody) and cell-mediated functions.

Incidence: The number of new cases of a disease within a specified period of time.

Integrated Risk Information System (IRIS): EPA’s primary chemical database of toxicity values.

Ion (Anion/Cation): An electrically charged atom or group of atoms formed by loss or gain of one or more electrons. An anion has an overall negative charge, while a cation has an overall positive charge.

Ion chromatography (IC): An analytical technique by which ions are separated and their concentrations in solution are measured. Ion chromatography is capable of detecting very low concentrations of anions or cations.

Ion exchange: A process by which ions the same charge are replaced by other ions of the same charge; for example, perchlorate (ClO_4^-) may be replaced with chloride (Cl^-) by ion exchange. This is accomplished using an ion exchange resin. *Ion chromatography* makes use of these resins.

Kinetic barriers: Refers to chemical reactions that will not occur unless a catalyst or energy are supplied.

Kinetics: The study of the rates and mechanisms of chemical or biological reactions or processes. A mechanism is the progression of the individual stepwise processes by which an overall reaction actually occurs. A *kinetic barrier* refers to a part of the mechanism that requires so much energy as to slow the reaction down. Compare with *thermodynamics*.

Lability: The speed with which a chemical can react or the speed at which a reaction occurs. Labile chemical reactions occur quickly. Lability is a descriptor relating to *kinetics* (see above) as opposed to *thermodynamics*. Perchlorate is not a *labile* oxidizing agent (see *oxidation-reduction reaction*).

Lowest-Observed-Adverse-Effect-Level (LOAEL): The lowest exposure at which there are statistically and biologically-significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group. Compare with *NOAEL*.

Maximum Contaminant Level (MCL): The maximum permissible level of a contaminant in water delivered to any user of a public water system. MCLs are enforceable standards.

Mechanism of Action: The mechanism (e.g., cytotoxicity) by which a substance exerts its toxic effect.

Metabolism (biotransformation): Biochemical processes (usually enzymatic in nature) that animal organisms have developed to chemically change foreign chemicals (toxicants). A parent chemical can be changed to one or more metabolites. The changes are aimed at rendering the chemical more excretable, a form of detoxication, but in some instances may create toxic metabolites.

Method Detection limit (MDL): The lowest concentration of a substance which can be measured with 99 percent confidence that the analyte concentration is greater than zero. The MDL is 3.143 times the standard deviation (see *reporting level*).

Modifying factor (MF): An uncertainty factor which is greater than 0 (zero) and less than or equal to 10; the magnitude of the MF depends upon the professional assessment of scientific uncertainties of the study and database not explicitly treated with the standard uncertainty factors (e.g., the characterization of exposure or sample size in the principal study).

Monitoring wells: Special wells drilled at specific locations where groundwater can be sampled at selected depths and studied to determine such things as the direction in which groundwater flows and the types and amounts of contaminants present.

Nanofiltration: See *reverse osmosis*.

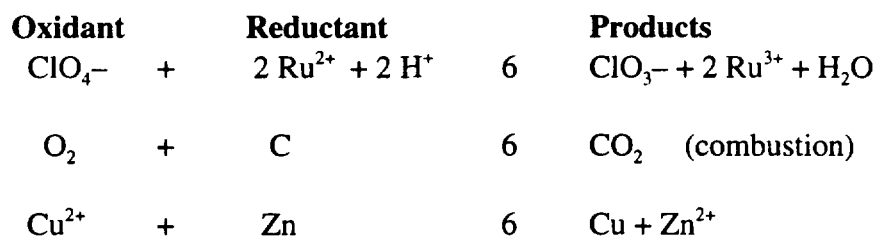
National Primary Drinking Water Regulation (NPDWR): Applies to public water systems and specifies a contaminant level, which, in the judgement of the EPA Administrator, will not adversely affect human health.

National Priorities List (NPL): EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System.

Neurotoxicity: Toxicity to the structure or function of the nervous system, including behavioral effects.

No Observed Adverse Effect Level (NOAEL): An exposure level at which there are no statistically and biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse, nor precursors to adverse effects. In an experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effect. Compare with *LOAEL*.

Oxidation-reduction (redox) reaction: A class of chemical reactions in which an *oxidizing agent* (oxidant) reacts with a *reducing agent* (reductant). In this class of reaction, there is a net transfer of electrons from the reducing agent to the oxidizing agent. Sometimes this results in the transfer of atoms or ions as well. In redox reactions, the oxidizing agent is reduced and reducing agent is oxidized. Acid, base, and water may be required, but oxygen is not a required component in redox reactions. Common examples of redox reactions are shown below:



Oxidizing agent: See *oxidation-reduction reaction*.

Parts per billion (ppb): The concentration (in units of mass) relative to a base of one billion, commonly used to express contaminant ratios, as in establishing the maximum permissible amount of a contaminant in water, soil, or air. One part per billion is equivalent to four drops of water in an Olympic-size pool (64,000 gallons).

1 ppb = 0.001 ppm = 1 nanogram/gram.

Parts per million (ppm): The concentration (in units of mass) relative to a base of one million, commonly used to express contaminant ratios, as in establishing the maximum permissible amount of a contaminant in water, soil, or air. One part per million is approximately equivalent to one quart on water in an Olympic-size pool (64,000 gallons). 1 ppm = 0.0001 percent = 1 milligram/kilogram.

Perchlorate (ClO_4^-): An anion (see *ion*) of chlorine and oxygen in which the central chlorine atom has an oxidation state of +7. As an oxidizing agent, perchlorate has a high kinetic barrier (see *kinetics*) to reduction.

Perchloric acid (HClO_4): The oxyacid of chlorine that contains one hydrogen ion (H^+) and one perchlorate ion (see above). Perchloric acid dissociates completely to perchlorate and hydrogen ion when dissolved in water. Perchloric acid is the strongest oxidizing agent in the series of chlorine oxyacids:

oxyacid	oxidizing formula	reaction strength	speed
perchloric acid	HClO_4	strongest	slowest
chloric acid	HClO_3	8	8
chlorous acid	HClO_2	9	9
hypochlorous acid	HOCl	weakest	fastest

Persistence: Refers to the length of time a compound stays in the environment, once introduced.

pH: A measure of the strength of an acid or base. pH is measured on a scale of 0 (zero) to 14 where 7 (seven) is considered neutral (neither acidic nor basic). Acids measure less than 7 on the scale. Bases measure greater than 7 on the scale. pH is related to the quantity of hydrogen ions present in a solution.

Precursor lesion: A lesion that precedes another in the development of disease or adverse toxic effect. The lesion is considered to be linked sequentially to the disease process.

Principal study: The study that contributes most significantly to the qualitative and quantitative risk assessment. This study typically serves as the basis for derivation of a dose-response estimate such as the RfD.

Quantitative Risk-Assessment: A multi-step process used to evaluate chronic human health risks associated with chemical, biological, and physical substances.

Reducing agent: See *oxidation-reduction reaction*.

Reference Dose (RfD): An estimate (with an uncertainty spanning perhaps an order of magnitude or greater) of a daily oral exposure to the human population (including sensitive subpopulations) that is likely to be without an appreciable risk of deleterious systemic effects during a lifetime.

Reporting Level: The lowest level at which some laboratories elect to report results of a chemical, physical, or biological analysis. In most cases, this level is two to three times the *Method Detection Limit*.

Reverse osmosis (RO): A treatment process used in water systems by adding pressure to force water through a semi-permeable membrane. Reverse osmosis removes most drinking water contaminants and is also used in wastewater treatment. *Nanofiltration* refers to membranes that have smaller pore sizes than normal RO membranes.

Risk assessment: The characterization of the potential adverse health effects of human exposures to environmental hazards. The process contains four components: hazard identification, dose-response assessment, exposure assessment, and risk characterization.

Risk characterization: The process of estimating the incidence or magnitude of a health effect under the various conditions of human exposure described in exposure assessment. It is performed by comparing the exposure and dose-response assessments. It also includes characterization of the uncertainties inherent in the process of inferring the risk.

Risk management: The process of evaluating alternative regulatory or mitigating actions to decrease risk and select among them. The selection process necessarily requires the use of value judgements on such issues as the acceptability of risk and the reasonableness of the costs of control.

Safe Drinking Water Act (SDWA): The law established to protect the quality of drinking water in the United States. This law focuses on all waters actually or potentially designated for drinking water use, whether from surface or *groundwater* sources. The SDWA authorizes EPA to establish safe standards of purity and requires all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this authority from EPA, also encourage attainment of secondary standards (nuisance-related, e.g. taste and odor effects).

Salt: A compound containing a fixed combination of anions and cations (see *ion*) so as to be electrically neutral (that is, have a net charge of zero). The cations and anions are bonded together by their mutual electrical attraction. Examples include ammonium perchlorate: $\text{NH}_4^+ \text{ClO}_4^-$; sodium chloride: $\text{Na}^+ \text{Cl}^-$; calcium carbonate: $\text{Ca}^{2+} \text{CO}_3^{2-}$; sodium benzoate: $\text{Na}^+ \text{C}_6\text{H}_5\text{CO}_2^-$; and potassium aluminum sulfate: $\text{K}^+ \text{Al}^{3+} (\text{SO}_4^{2-})_2$.

Selectivity: The degree to which an analytical testing method is free from interference by other species contained in the sample matrix.

Sensitivity: The ability of a method to discriminate between small differences in analyte concentration. Two factors limit sensitivity: the slope of the calibration curve and the reproducibility, i.e. precision, of the measuring device.

Standards: Norms that impose limits on the amount of pollutants or emissions produced. EPA establishes minimum standards, but states are allowed to be stricter.

Subchronic exposure: Multiple or continuous exposures occurring over less than a significant portion of an animal or individual's lifespan.

Subchronic toxicity study: A toxicity study designed to measure effects from a subchronic exposure to a chemical. Typically 10% of the duration of a chronic study such as 3 months (90-days) as opposed to a 2-year *bioassay*.

Superfund: The EPA program operated under the legislative authority of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) and SARA (Superfund Amendments and Reauthorization Act) that funds and carries out solid waste emergency and long-term removal and remedial activities. These activities include establishing the *National Priorities List*, investigating sites for inclusion on the list, determining their priority, and conducting and/or supervising the cleanup and other remedial actions.

Supporting studies: Studies that contain information that is useful for providing insight and support for the conclusions regarding dose-response assessment.

Systemic effects: Systemic effects are those that require absorption and distribution of the toxicant to a site distant from its portal of entry (e.g., gastrointestinal tract, skin or respiratory tract) at which point effects are produced.

Target tissue: Most chemicals that produce toxicity do not cause a similar degree of toxicity in all organs but usually elicit the major toxicity in only one or two organs. These sites are referred to as the target organs of toxicity of a particular chemical. The target organ of toxicity is often not the site of highest internal concentration of the chemical. The concentration attained in the target tissue depends on the disposition of the chemical, that is, its absorption, distribution, metabolism (biotransformation), and excretion. For example, lead is concentrated in the bone, but its effects are in the nervous system.

Thermodynamics: The branch of chemistry that deals with the energy changes that occur in chemical reactions and predicts which reactions will occur spontaneously without adding energy from an outside source and which reactions will not occur. A reaction that is thermodynamically favored may have a *kinetic barrier* that makes it progress so slowly as to be unobservable. Thermodynamics does not deal with the rate at which reactions occur. Compare with *kinetics*.

Thyroglobulin: An iodine-containing glycoprotein of high molecular weight occurring in the colloid of the follicles of the thyroid gland; the iodinated tyrosine moieties of thyroglobulin form the active hormones T3 (triiodothyronine) and T4 (thyroxine) which are released into the blood on proteolysis of thyroglobulin.

Thyroid Stimulating Hormone (TSH, thyrotropin): A hormone from the anterior pituitary that has affinity for and specifically promotes the growth of, sustains, and stimulates the hormonal secretion of the thyroid gland.

Thyroxine (T4): One of the thyroid hormones. Considered the major hormone elaborated by the thyroid, formed from thyroglobulin and transported mainly in the blood serum thyroxine-binding globulin. Its chief function is to increase the rate of cell metabolism. Thyroxine is deiodinated in peripheral tissues (liver, kidney, heart) to form T3 (triiodothyronine), presumably the active "tissue" form of thyroid hormone.

Total dissolved solids: The quantity of dissolved material that is left behind when a given volume of water is evaporated away.

Trichloroethylene (TCE): A stable, low boiling-point colorless liquid, that is toxic if inhaled. Used as a solvent or metal degreasing agent, and in other industrial applications. It is also known as 1,1,1-trichloroethene.

Triiodothyronine (T3): One of the thyroid hormones. An organic iodine-containing compound liberated from thyroglobulin by hydrolysis. It has several times the biological activity of T4 (thyroxine) and is thought by some to be the “tissue-active” form of thyroid hormone.

Uncertainty factors (UFs): A series of factors used in derivation of a *reference dose (RfD)* meant to compensate for the uncertainty in extrapolating toxicity data from an animal or human study to the general population. UFs account for considerations such as variation in susceptibility among individuals in the general population, uncertainty in extrapolating from effects in animals to humans, and uncertainty in extrapolating from *subchronic* to *chronic* studies.

Volatile organic compound (VOC): An organic (carbon-containing) compound that evaporates easily at room temperature. VOCs are commonly used in dry cleaning, paint stripping, metal plating, and machinery degreasing.

Water purveyor: A public utility, mutual water company, county water district, or municipality that delivers drinking water to customers.